Why Reprocess?

The Impact of Reprocessing Efforts on the Mid-Atlantic's Surface Current Product

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Study Purpose & Goals

Ocean Observing Systems provide HFR data in (near) real-time. Is there a benefit to creating a reprocessed product?

- Quantify the differences between a year-long real-time dataset and a reprocessed dataset.

- Are the differences significant for intended uses of data?

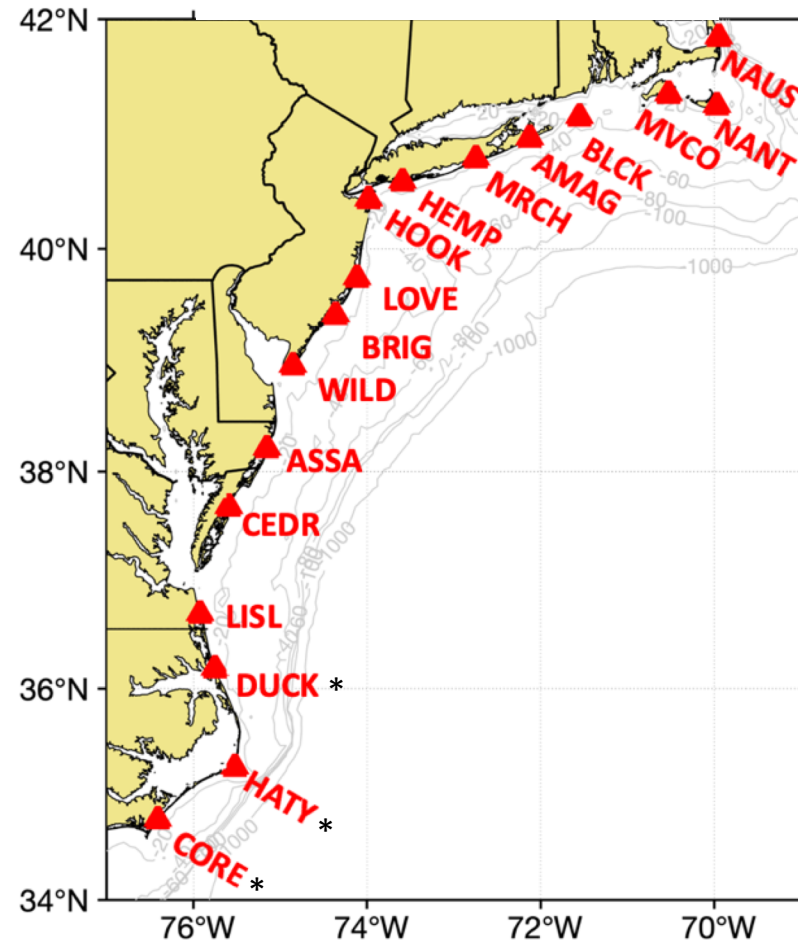- Apply tests to assess quality of each dataset.

Background

MARACOOS Mid-Atlantic Surface Current Product

- ➢ 17 Long range CODAR SeaSonde systems

- ➢ Hourly surface current velocity maps

- ➢ 6 kilometer grid

- ➢ Unweighted least squares combination method of computing surface currents from station radial data
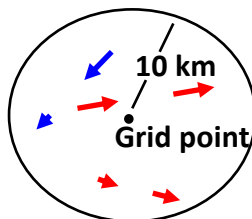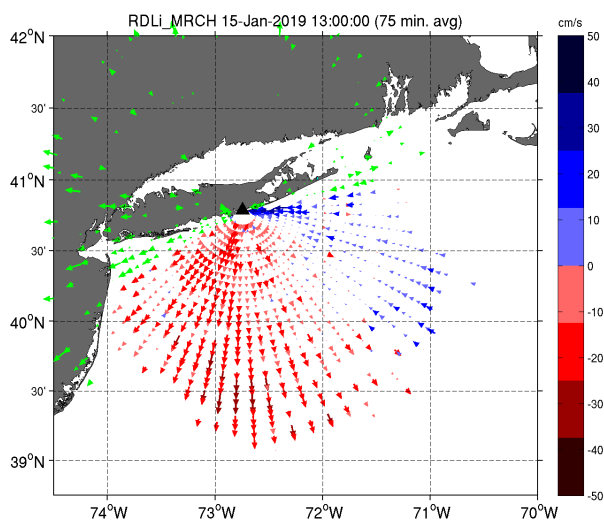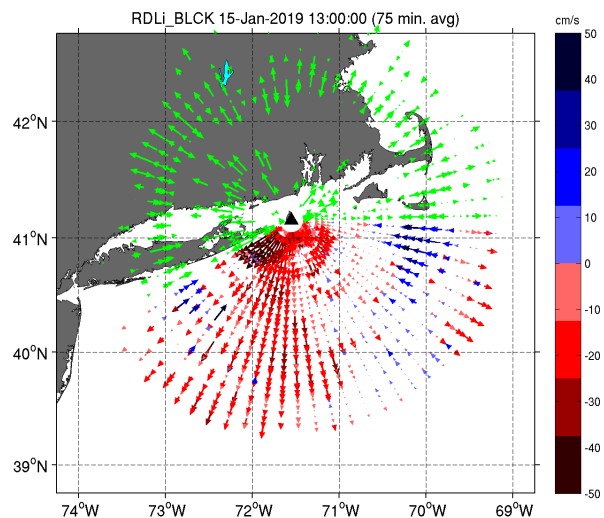
- ➢ Focus on 2017 dataset

5 MHz stations contributing to MARACOOS surface current maps.

* Stations operated by SECOORA

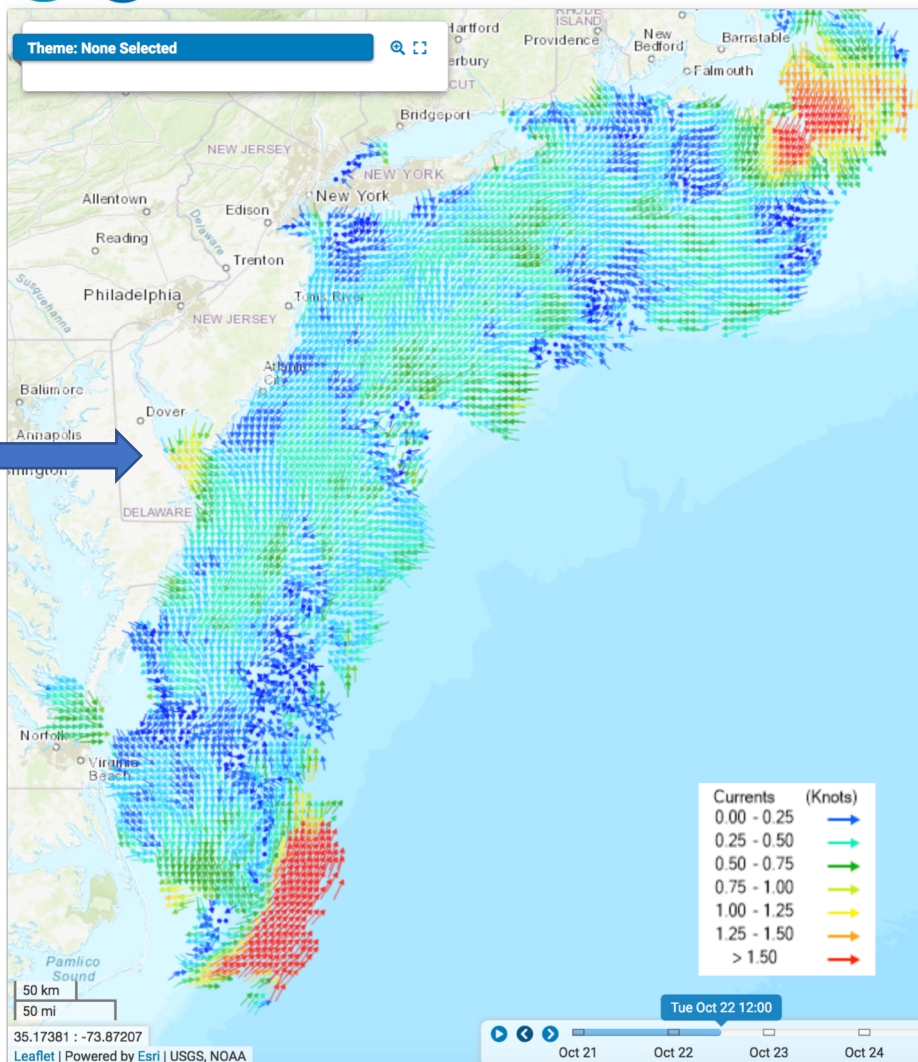Station radial velocities → Combined with unweighted least squares method on 6 km grid → Total surface current velocities
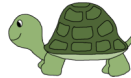
Potential Problems with Real-Time HFR Data

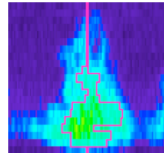Bad data introduced after a station outage
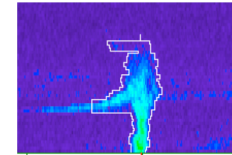
Communications outage

Data transfer delay

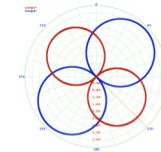First order line settings not capturing all sea echo

Incorrect site computer time
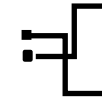
Interference processed into radials

New antenna pattern needs to be measured

Receive antenna rotated

Receiver cable swap

Software problem causes spectra or radial level processing to stop

Methods

Real-Time Product Radial QA/QC

- Operator review of hardware and radial diagnostic plots

- Operator review of radial maps and radial distributions

- Operator evaluation of which radial type to use in totals (ideal or measured pattern)

- Radials over set maximum speed removed by manufacturer software before creation of radial file

- Invalid locations flagged in radial file by manufacturer software tool

- Radial file syntax requirements must be met

Reprocessing Methods

- Systematic review of data and diagnostics by QC group to remove questionable data

- Evaluation of best calibration pattern having the benefit of yearly context and (possibly) new patterns

- Reprocessed radials from spectra when appropriate

- At North Carolina sites, we used radials with additional radial metric QC applied (Haines et al, 2017)

- Applied QARTOD radial QC tests and created new radial files with QC flags

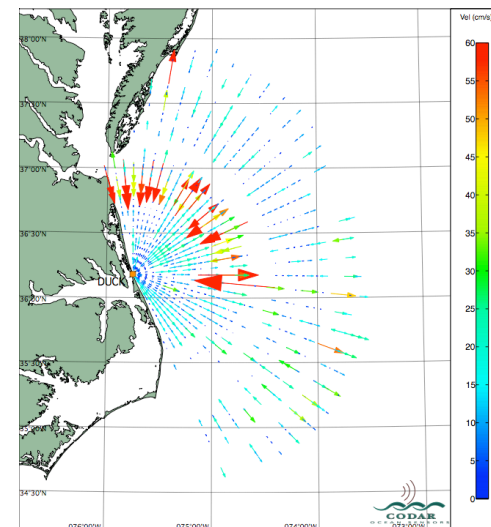- Computed totals with radials that did not fail any of the QC tests

QARTOD QC Tests

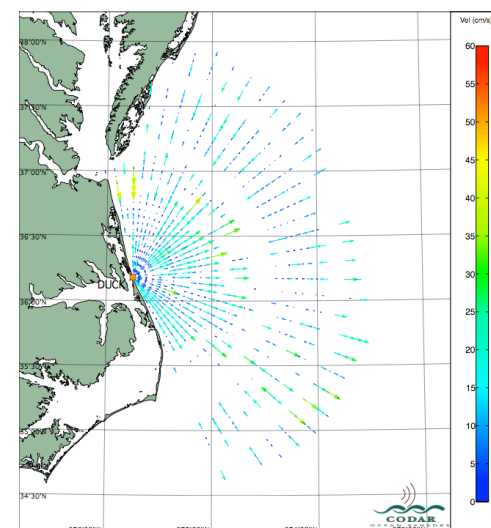| Test Code	Test Name	Suspect Flag	Fail Flag
QC06	Syntax	N/A	see text
QC07	Max Threshold	N/A	velocity > RSPDMAX RSPDMAX = 300 cm/s
QC08	Valid Location	N/A	VFLG = 128
QC09	Radial Count	RCMIN[a] >= count <= RCLOW[a]	count < RCMIN[a]
QC10	Spatial Median	N/A	velocity > CURLIM RCLIM=2.1 cells, ANGLIM = 10 degrees, CURLIM[b] = 30 or 50 cm/s

Tests not applied to 2017 real-time data.

[a] RCMIN and RCLOW are site dependent thresholds

[b] Stations LISL, DUCK, HATY, CORE use 50 cm/s. All others use 30 cm/s.

Original radial map

Map after radial data flagged by spatial median test was removed

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Implementation of QARTOD QC Tests

codar_processing toolbox

Mike Smith (Rutgers University)

Python repository available at
https://github.com/rucool/codar_processing

Implementation of Radial Metric QC

qccodar toolbox

Sara Haines (University of North Carolina)

Python repository available at
https://github.com/nccoos

HF Radar Community Software Tools
https://github.com/rowg

- Created by Radio-wave Operators Working Group (ROWG)

- HFR-related data processing, management & display

- 23 code repositories

- 10 contributing authors

- MATLAB, Jupyter Notebook, Python, Shell and HTML

Reprocessing Results: Radial Changes

Addition of Missing Radial Files

Site	Additional Hourly Files	Additional Days	% Increase
CORE	7274	303.1	731.8
NANT	1098	45.8	16.1
HATY	876	36.5	11.5
BRIG	753	31.4	9.8
MVCO	432	18.0	6.2
ASSA	418	17.4	5.0
DUCK	313	13.0	3.7
CEDR	62	2.6	0.8
Other Sites	11	0.5	0.1

Removal of Radial Files

Site	Hourly Files Removed	Days Removed
HOOK	2538	105.8
HEMP	516	21.5
NAUS	480	20.0
LOVE	1	0.0

Net Total Added: 7702 files

5.9% Increase

Radial Reprocessing

CEDR Distribution Index

Index is % of radial grid cells with >80% temporal coverage for the week
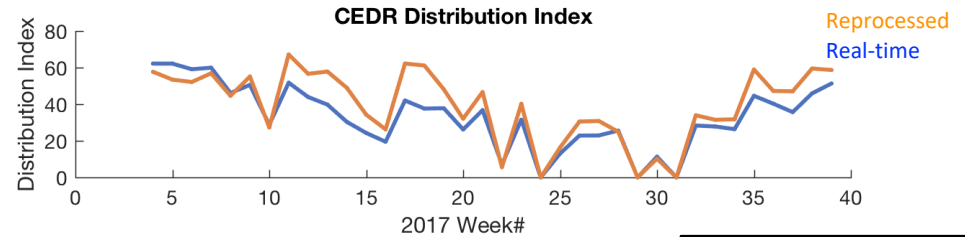
Radial distributions at CEDR station (Week 17 April 24 – Apr 30 2017)
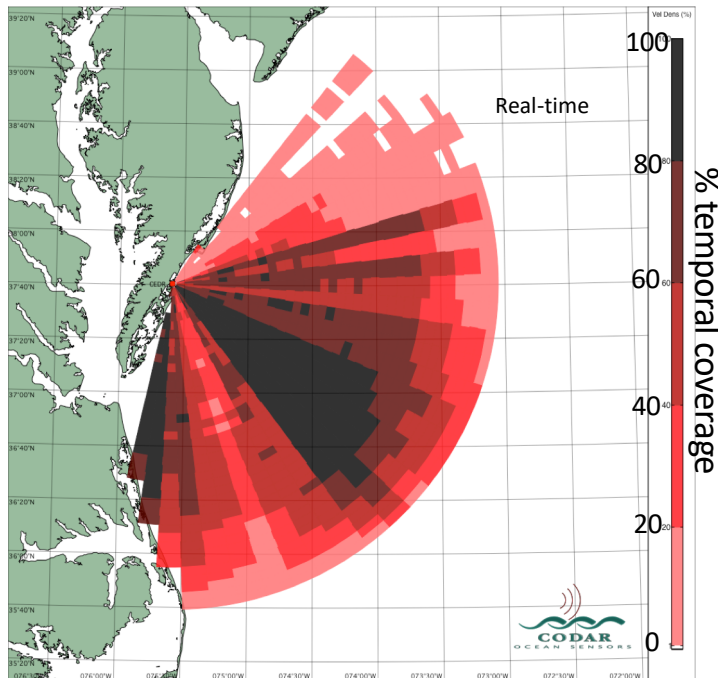
Using January measured pattern
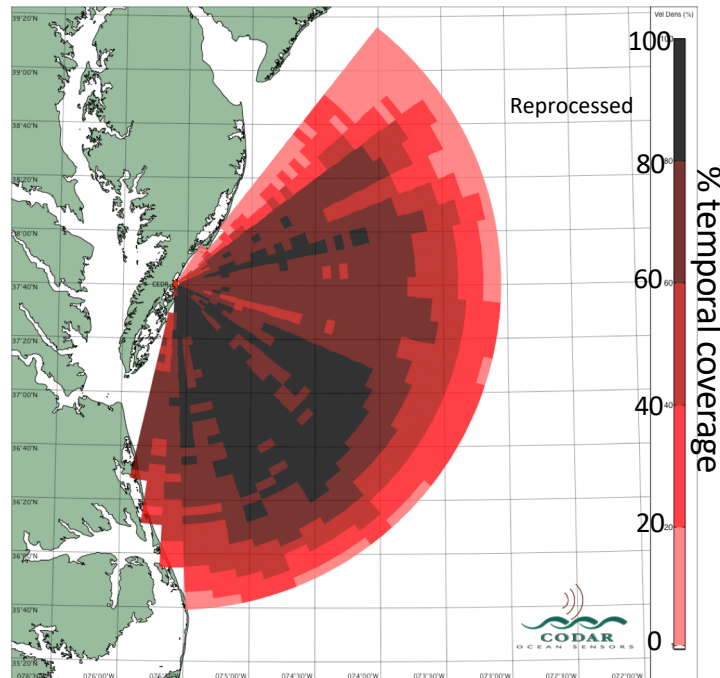
Using September measured pattern

Same equipment & environment, same method of pattern measurement, but applying another pattern yielded a better distribution & more data!
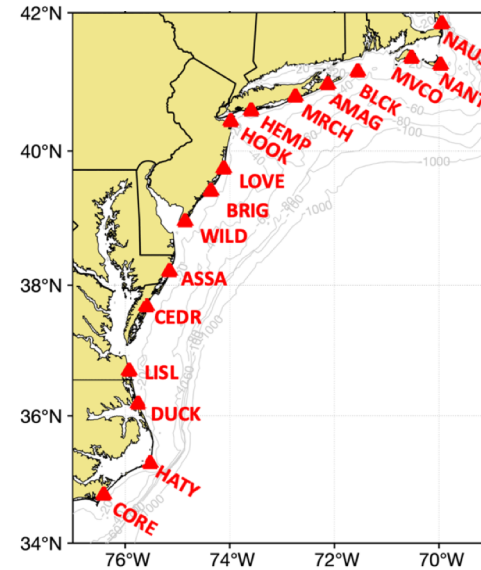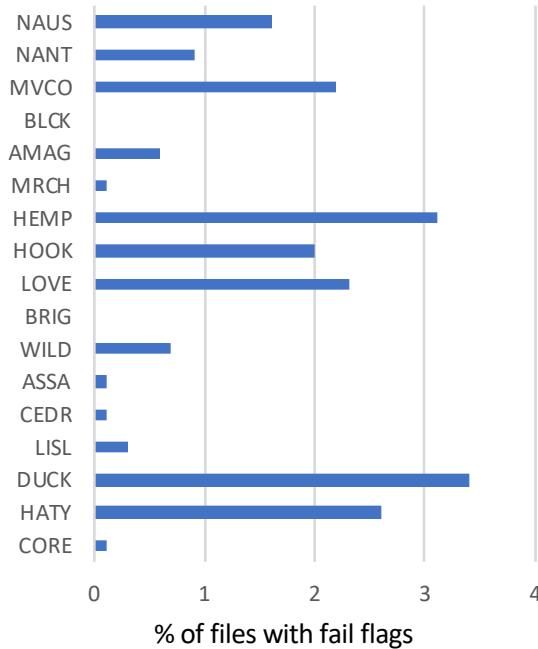
QARTOD QC Flags - Radial Count
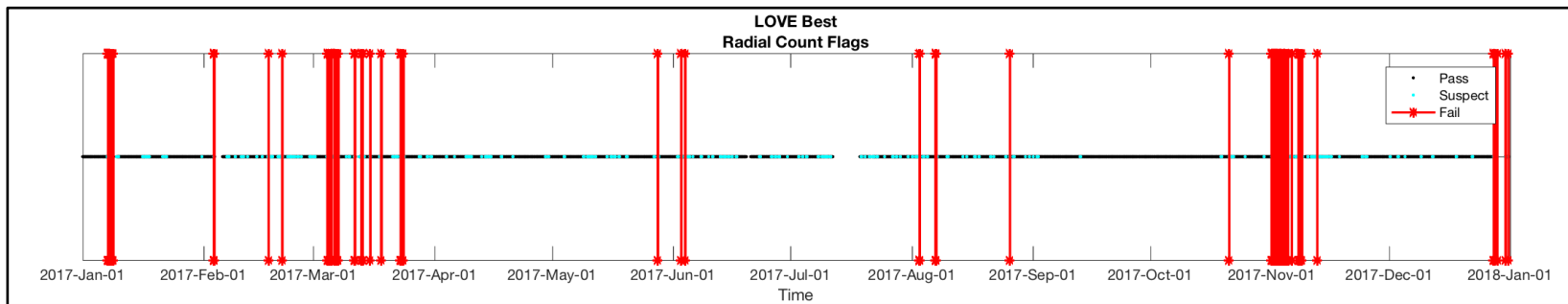
QARTOD QC – Spatial Median
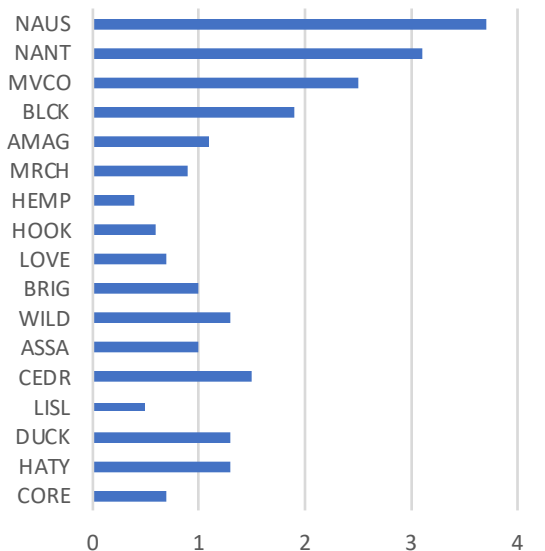
Average of % failure within radial files

AMAG Best QC10 Fail Flags
Jan 01 to Dec 31 2017: 8610 files
Black > 1 flag, Red > 61 flags
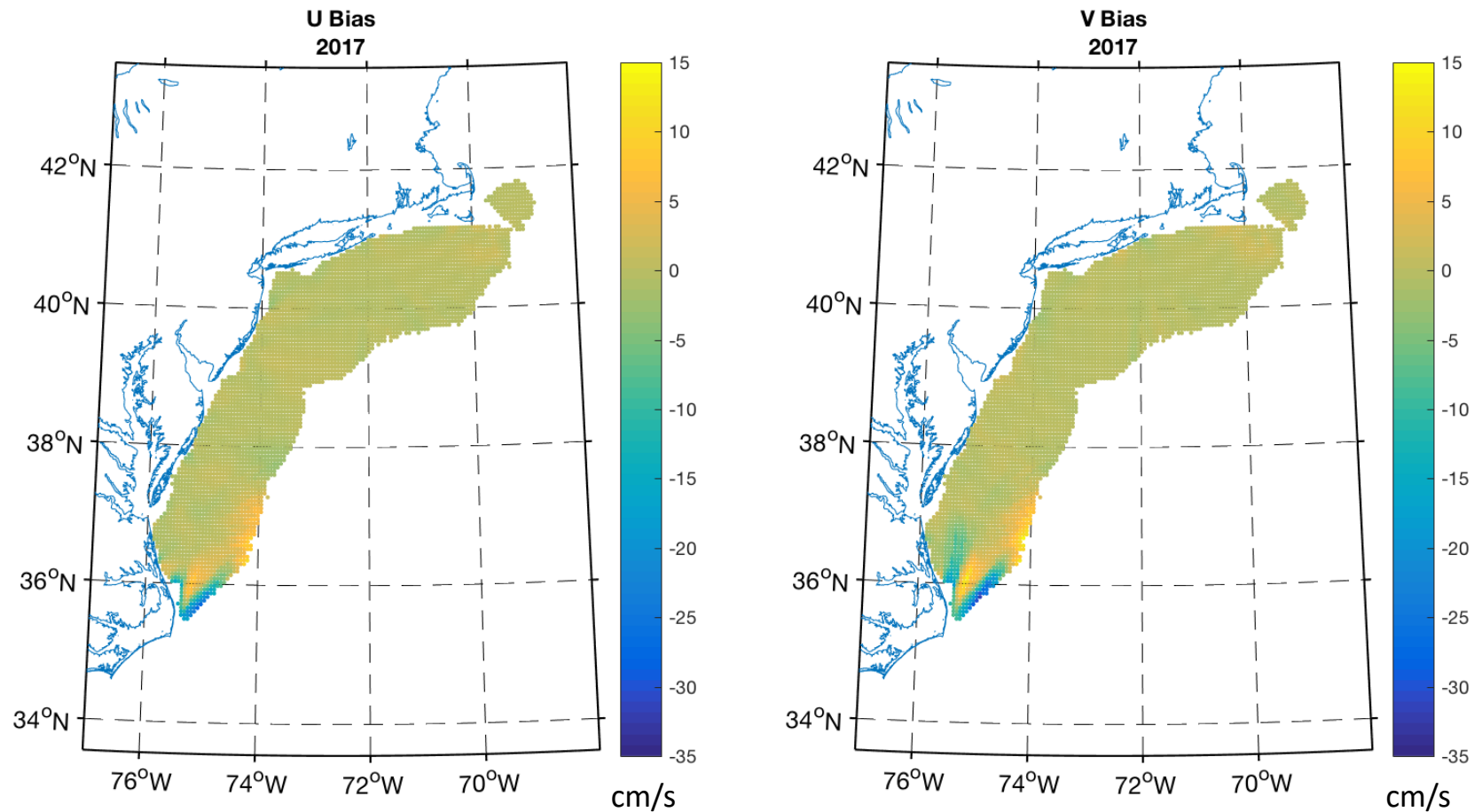

AMAG Spatial Median Test Failure Flags
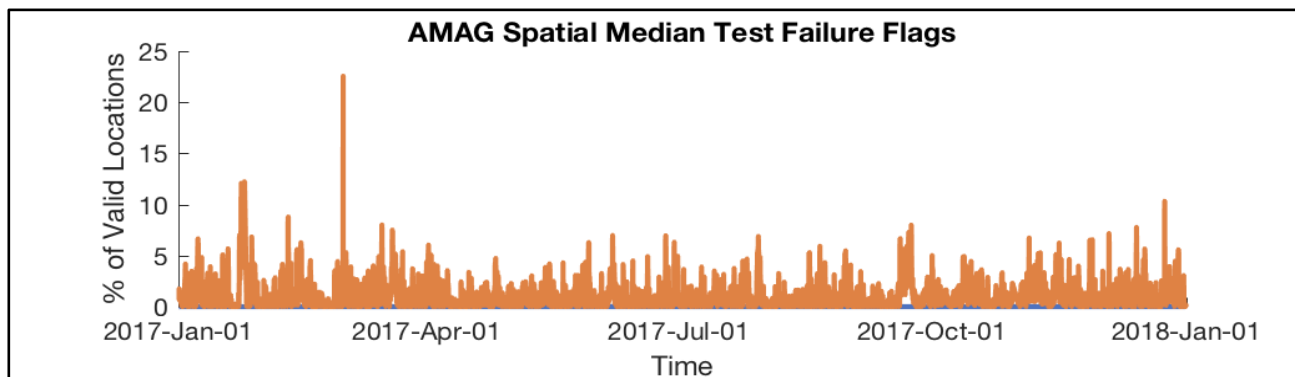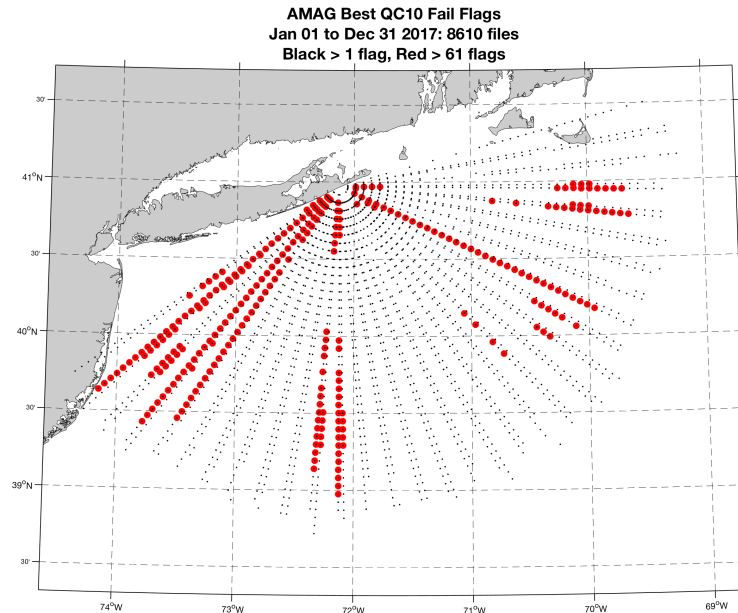
Summary: Improvements to Radial Inputs

- Hardware operating properly at times of radial measurement

- Valid pattern applied throughout the year

- Net Addition of 7702 radial files
  - Addition of 11237 missing radial files
  - Removal of 3535 radial files with data of questionable quality

- 38% of radial files were reprocessed from spectra

- 14% more radials were flagged with additional QARTOD QC tests

- Radial Metric QC in use for North Carolina stations

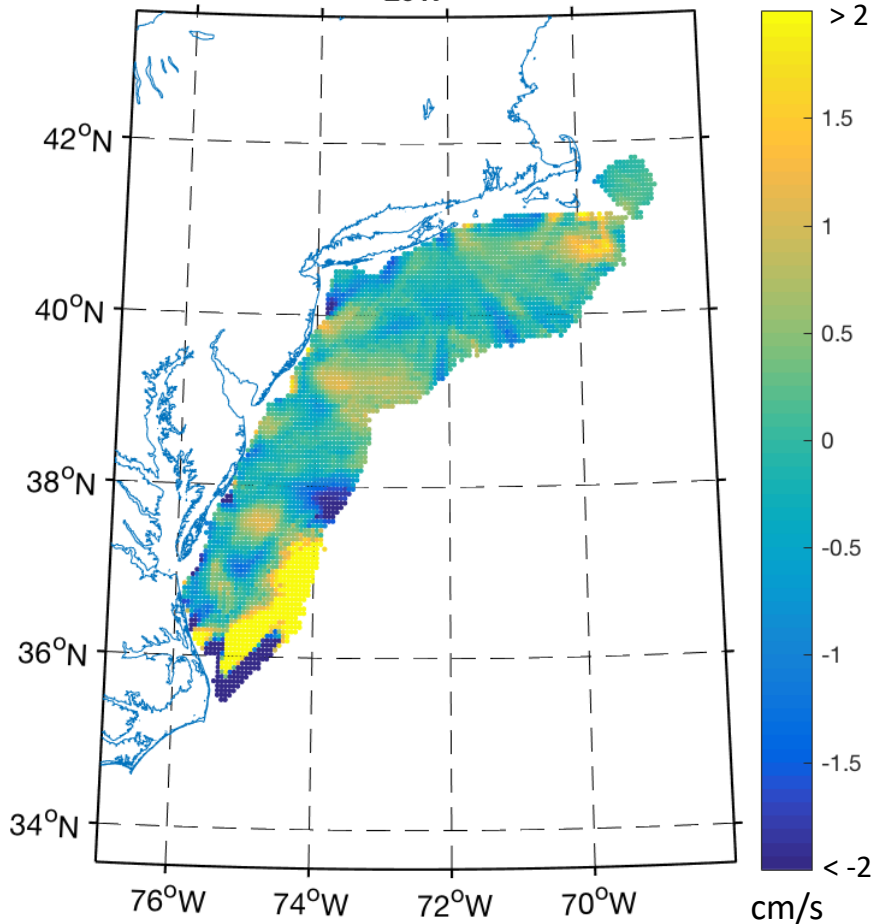# Surface Current Map Comparisons

Note: Both reprocessed and real-time surface current maps only use total vectors with GDOP < 1.25
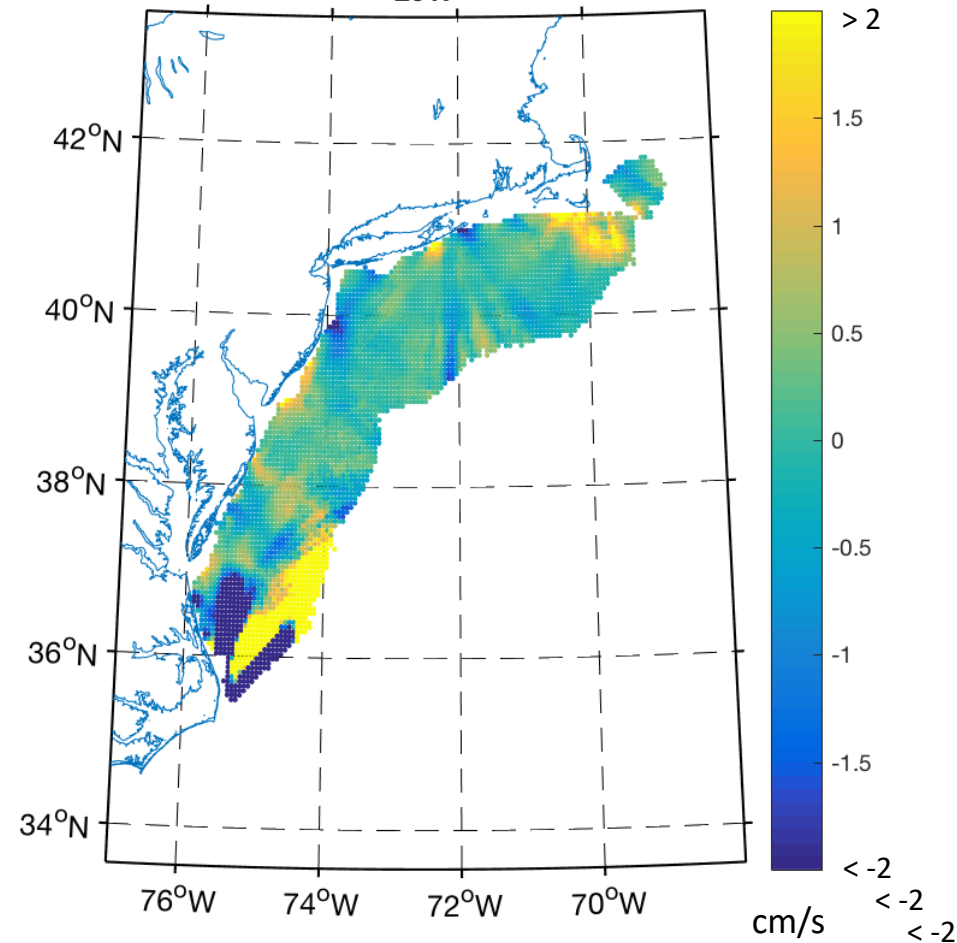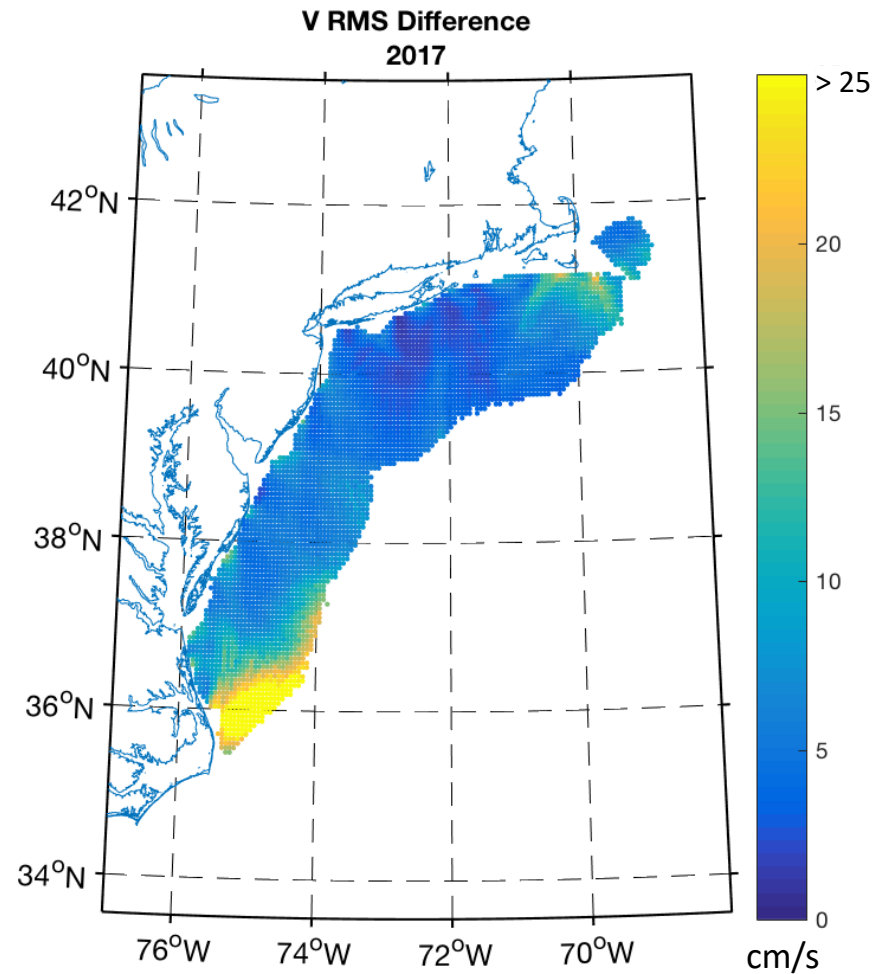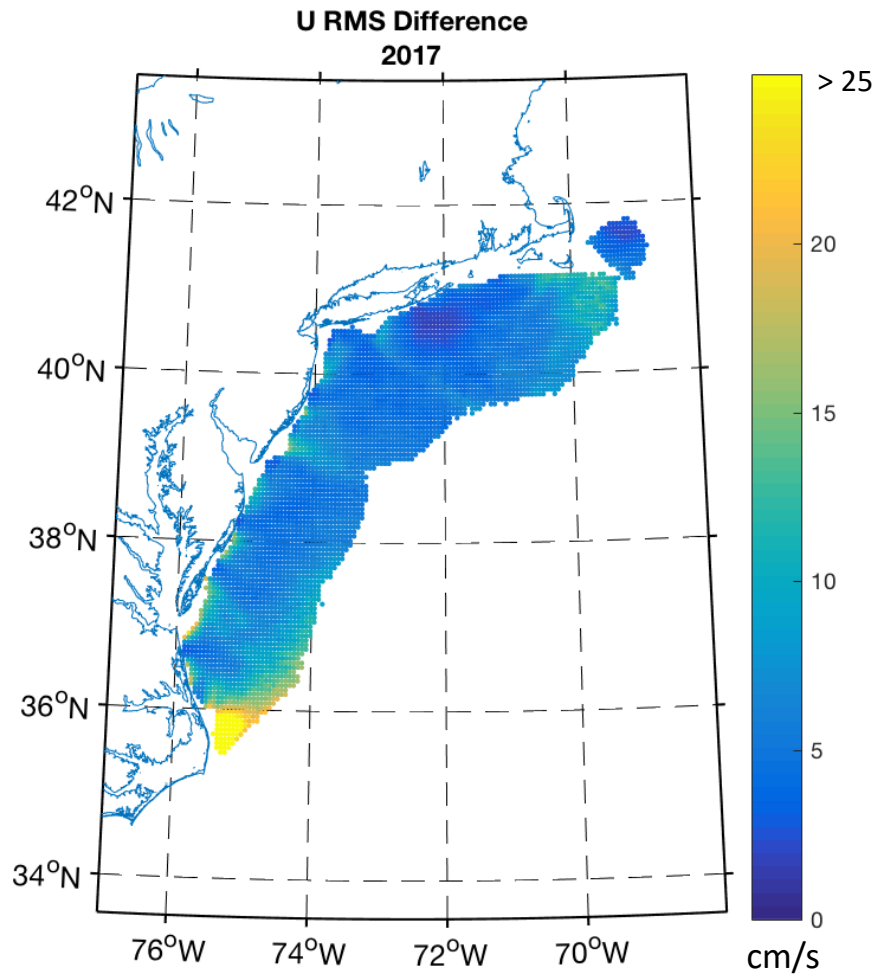
Difference in Yearly Average Current
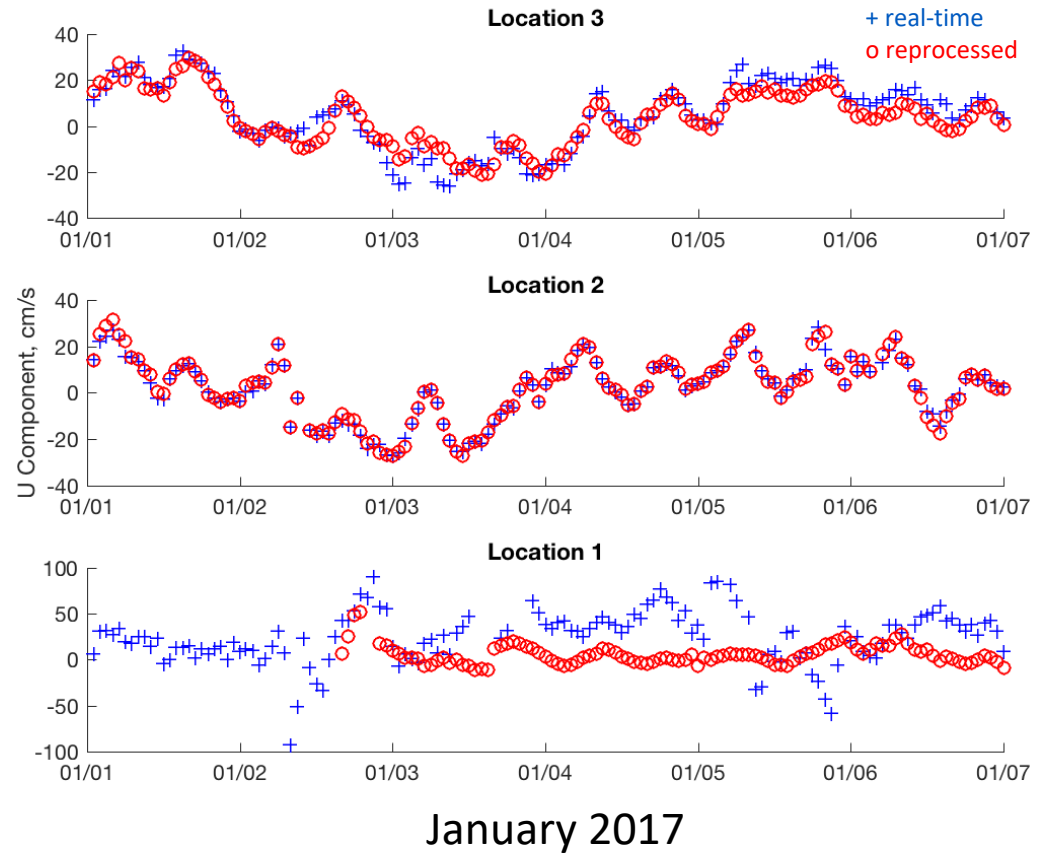
Difference in Yearly Average Current

RMS Differences

U Component of Velocity

Complex Correlation January 2017

Location 3
+ real-time
o reprocessed

Location 2

U Component, cm/s

Location 1

January 2017
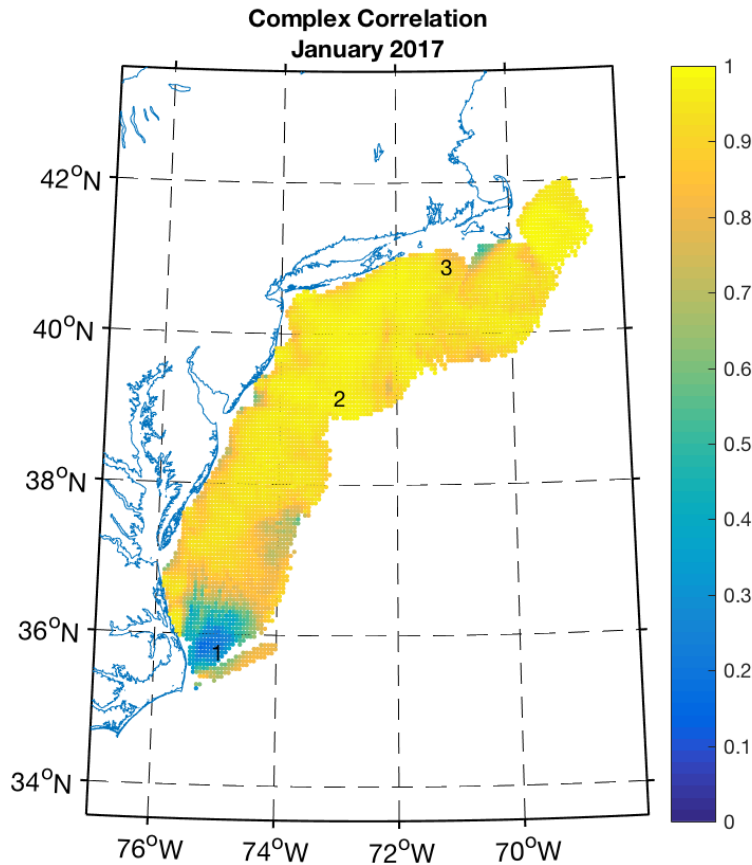
V Component of Velocity

January 2017

Realtime Monthly Mean January 2017 / Reprocessed Monthly Mean January 2017

✓ More data with CORE station included
✓ Gulf Stream position shift!
✓ Suspect vectors near coast are gone (Note: Both maps use criteria GDOP<1.25)
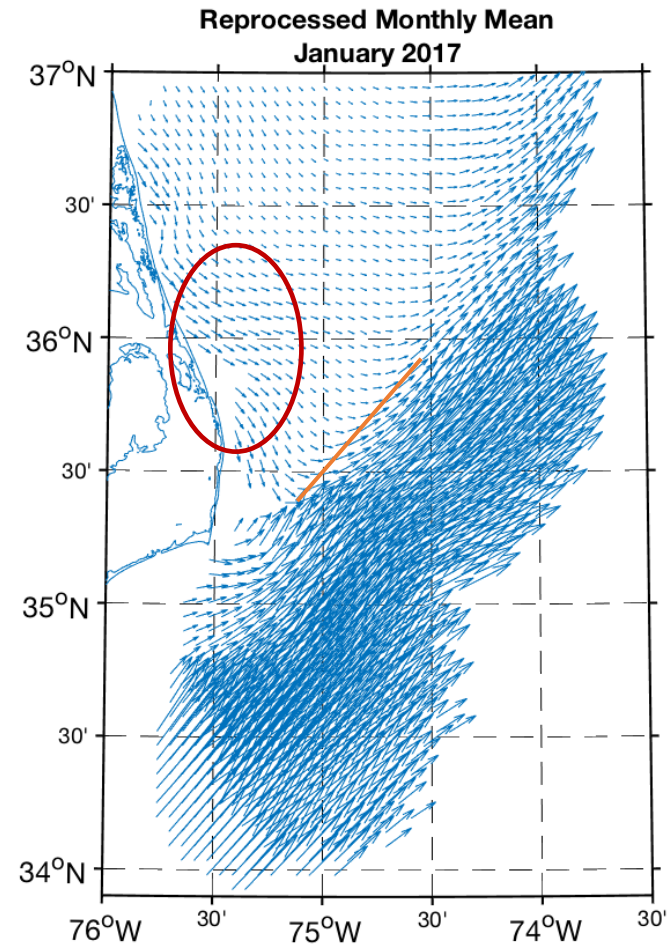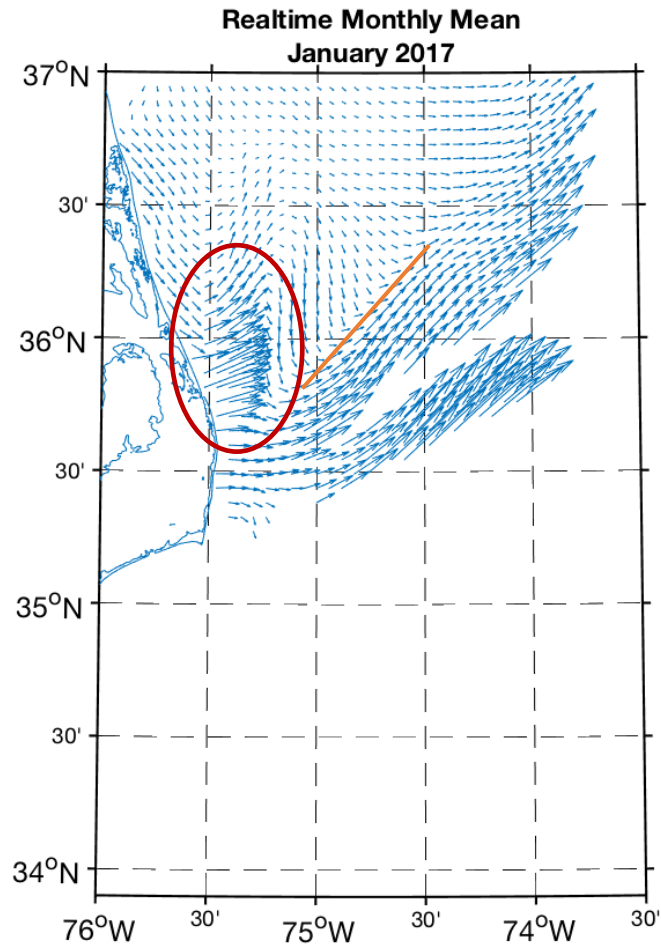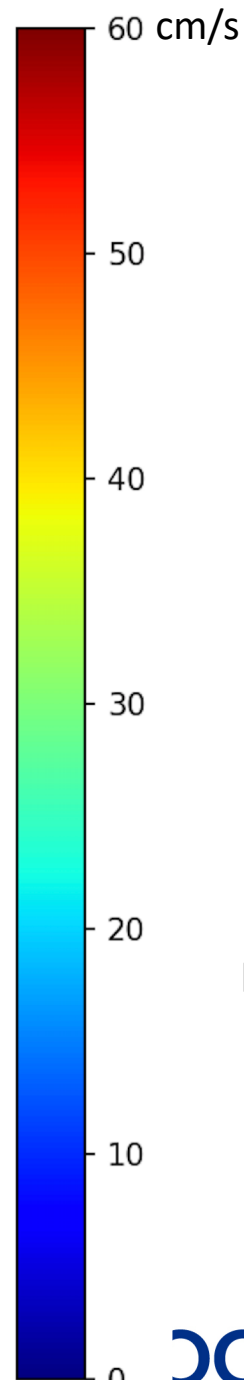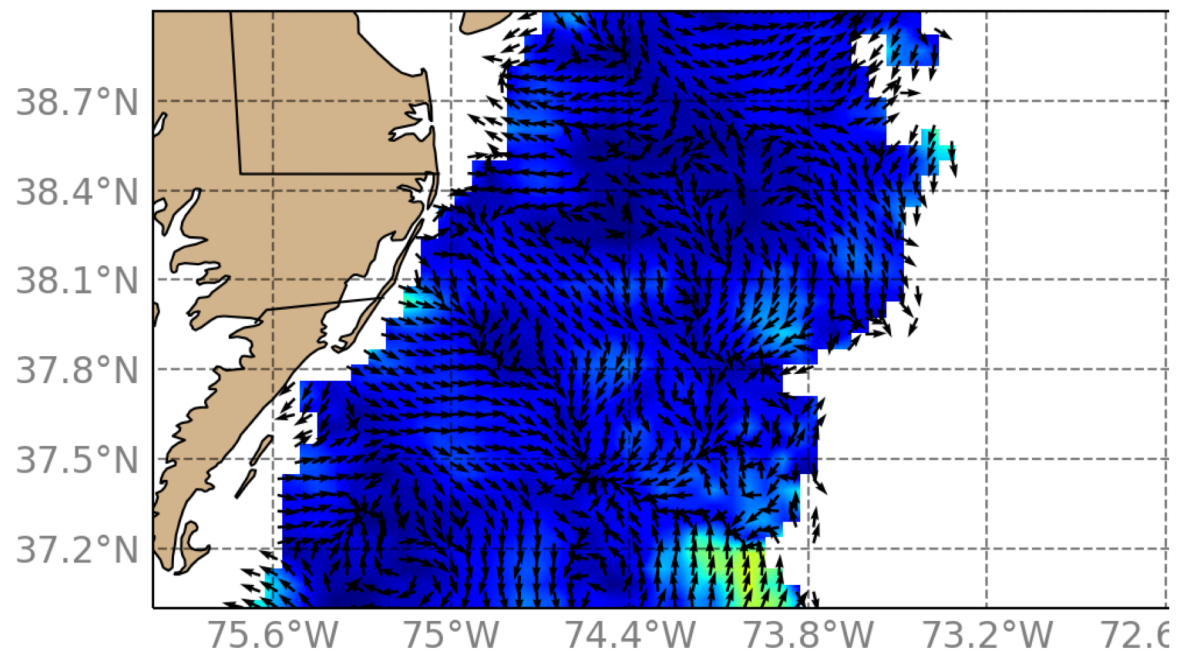
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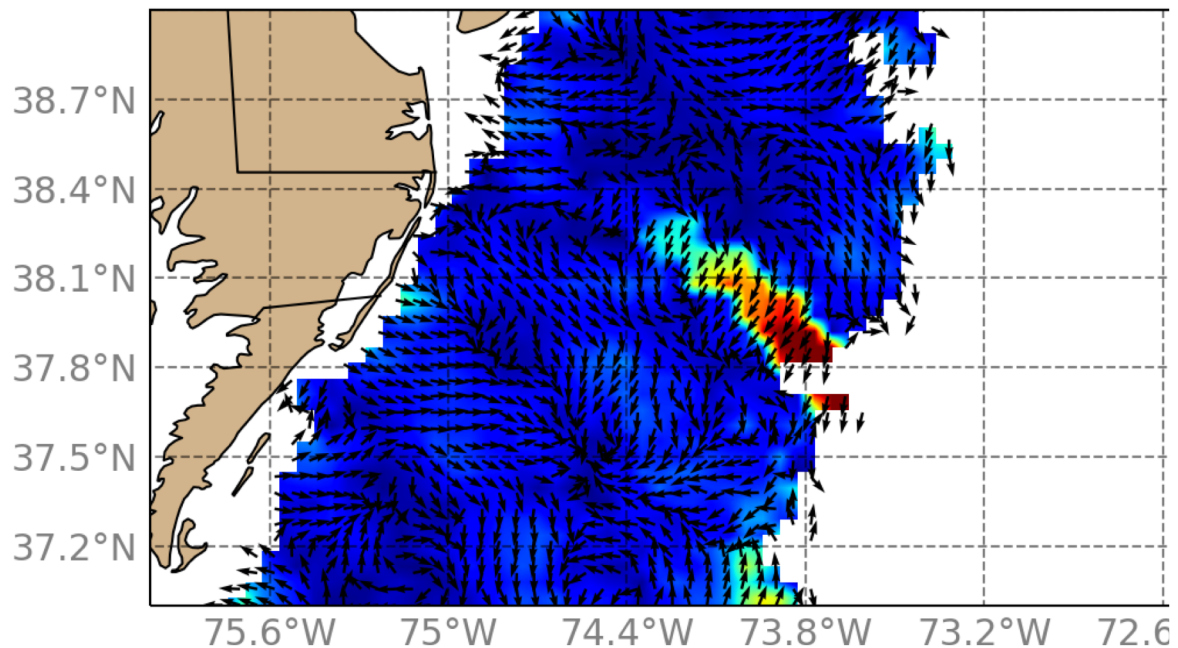
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MARACOOS 6km Sea Surface Currents
EasternShore - 20171112T200000Z

Real-Time Map

Reprocessed Map

MARACOOS 6km Sea Surface Currents
EasternShore - 20171125T230000Z
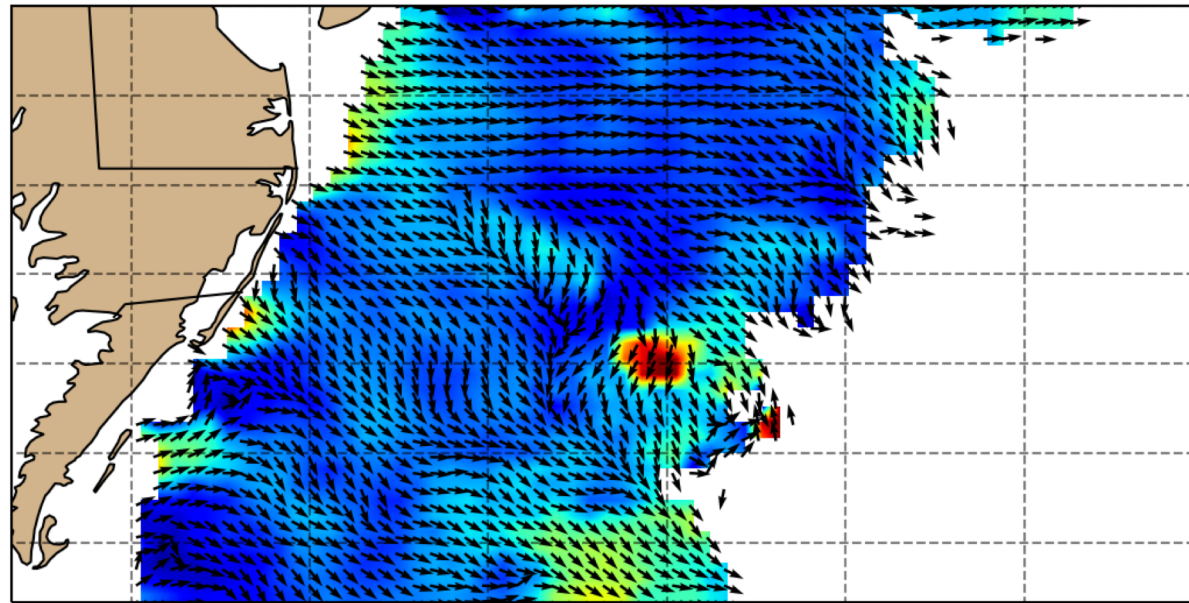
Real-Time Map

Reprocessed Map

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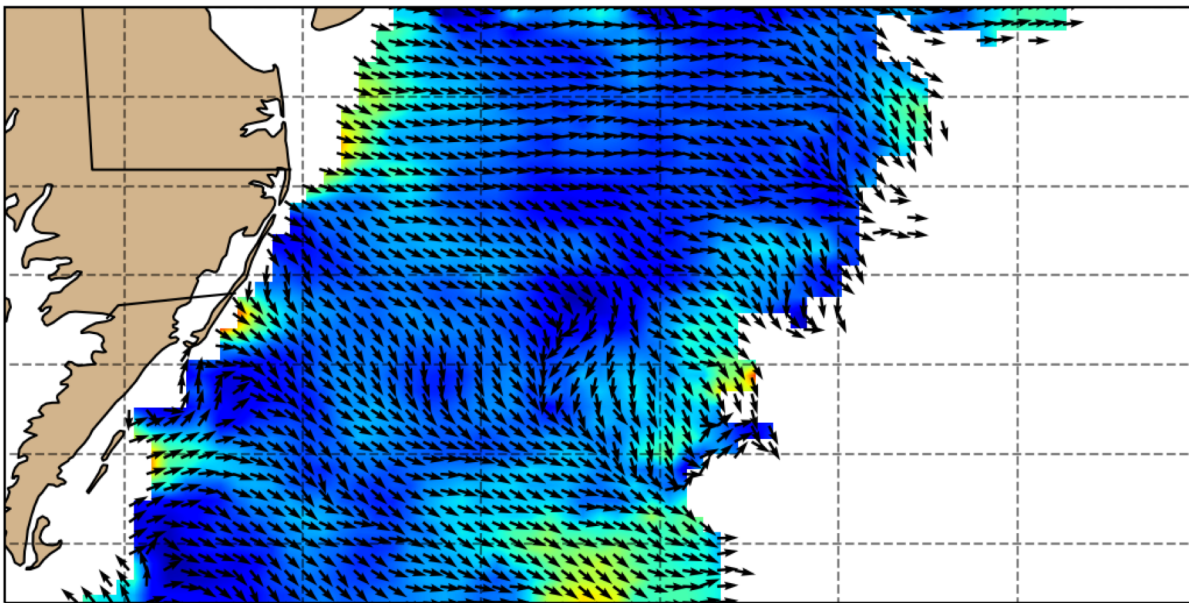
MARACOOS 6km Sea Surface Currents
EasternShore - 20171231T130000Z

Real-Time Map
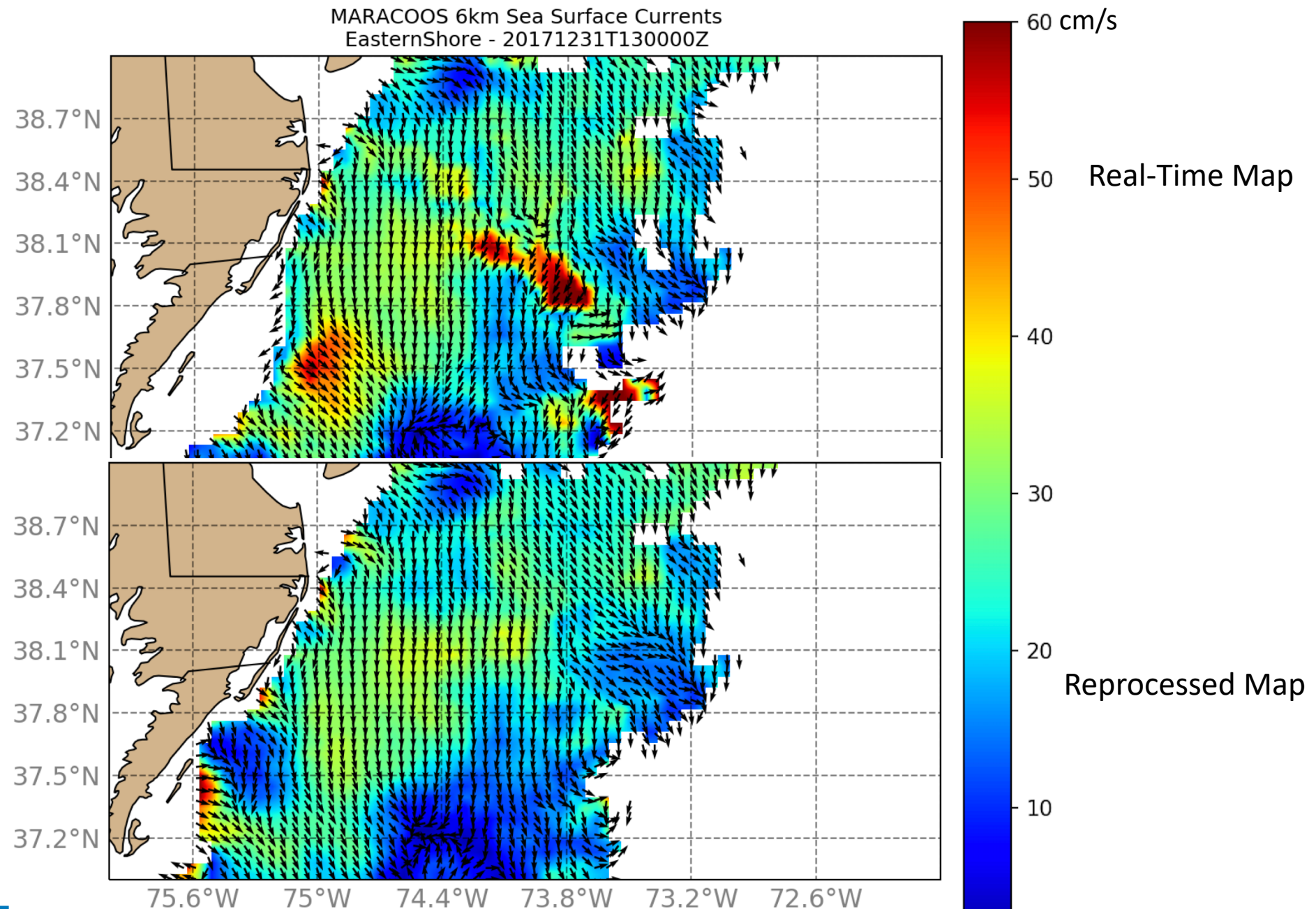
Reprocessed Map

Skill at Predicting Drifter Tracks

2017 Coast Guard Drifters (SLDMB)
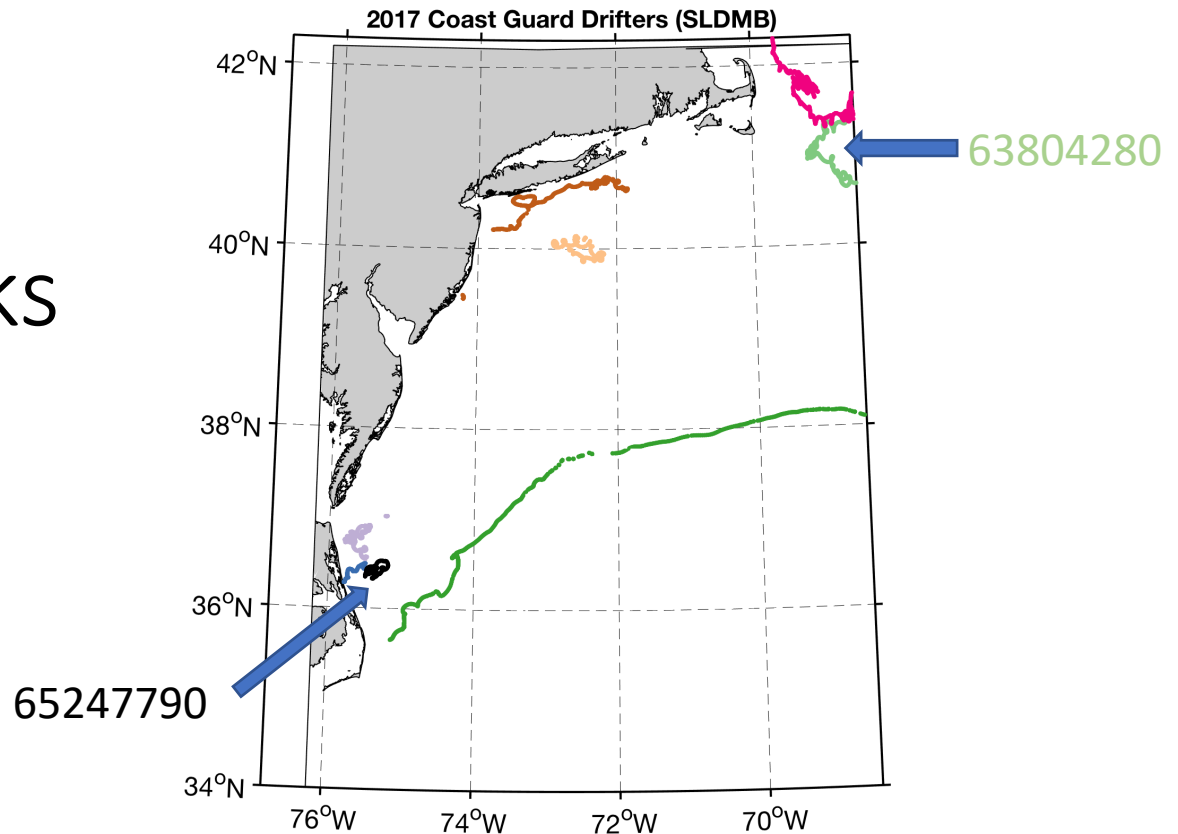
Drifter	Average Skill		Number of Scores		Area
	Realtime	Reprocessed	Realtime	Reprocessed	
63783850	0.25	0.26	64	64	VA Beach
63804280	0.71	0.47	2	17	Cape Cod
64065020	0.28	0.32	7	12	Outer Banks / Gulf Stream
64116430	0.52	0.55	21	20	New Jersey
64502470	0.43	0.43	5	6	Outer Banks
64529230	0.46	0.5	61	50	Cape Cod
65241210	0.37	0.37	57	58	New Jersey
65247790	0.21	0.47	26	25	Outer Banks

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Conclusions

- Significant differences may exist between real-time and reprocessed surface current velocities.

- Some improvements were noted by visually comparing the two sets of surface current maps and seeing fewer outliers in the reprocessed product. This could be quantified.

- Skill at predicting a drifter track was improved by using the reprocessing product for one case near the Outer Banks. In other cases, skills were similar.

- Additional work is needed to assess/compare data quality between the two data sets.

THANK YOU!

MARACOOS HF Radar Operators & QC Team Members

Rutgers University: Hugh Roarty, Michael Smith, Laura Nazzaro, Ethan Handel, Josh Kohut, Travis Miles

Old Dominion University: Teresa Updyke

University of Massachusetts Dartmouth: Rich Arena, Kate Trembley

SECOORA HF Radar Operators & QC Team Members

University of North Carolina: Mike Muglia, Sara Haines, Patterson Taylor, Nicolas DeSimone, Anthony Whipple